Control Number: 50595

Item Number: 201

Addendum StartPage: 0

Public Utility Commission of Texas

Employee Training Report
Required by 16 Texas Admin. Code § 25.97(d)

PROJECT NO. 50595

AFFECTED ENTITY: Guadalupe Blanco River Authority

General Information

Pursuant to 16 Texas Admin. Code § 25.97(d)(2), not later than the 30th day after the date an affected entity finalizes a material change to a document or training program, the affected entity must submit an updated report. The first report must be submitted not later than May 1, 2020.

Instructions

Answer all questions, fill-in all blanks, and have the report notarized in the Affidavit.

Affidavit

A representative of the affected entity must swear to and affirm the truthfulness, correctness, and completeness of the information provided by attaching a signed and notarized copy of the Affidavit provided with this form.

Filing Instructions

Submit four copies (an original and three copies) of the completed form and signed and notarized Affidavit to:

Central Records Filing Clerk
Public Utility Commission of Texas
1701 N. Congress Avenue
P.O. Box 13326
Austin, Texas 78711-3326
Telephone: (512) 936-7180

Affected Entity: Guadalupe Blanco River Authority **PROJECT NO.** 50595

1. Provide a summary description of hazard recognition training documents you provide your employees related to overhead transmission and distribution facilities.

The Guadalupe Blanco River Authority does not perform any maintenance on any of it's overhead transmission lines. All maintenance is performed by an outside contractor.

The GBRA Safety Manual has a section devoted to Electrical Power Transmission. Every employee is issued a Safety Manual upon hire. In addition, GBRA has a Safety Committee that reviews the Safety Manual and makes needed additions or changes. GBRA has also hired a Safety Manager. GBRA hired TEEX to conduct two one-day training classes specially for electrical safety on October 3 and October 9, 2019. The training was not held in 2020 because of the Covid-19 pandemic. Another electrical safety training, conducted by TEEX, is scheduled for May 12 and 20, 2021. GBRA is also reaching out to Hi-Line Engineering to schedule a 4 hour class on electrical hazards.

The outside contractor provided the following description of their training:

Our safety and training is for the most part On the Job Training and Safety. All the operators are required to view the training and safety disc that comes with the training being operated with the assistance of myself or crew foreman on proper use and setup of the equipment.

All employees are trained in Hurt Man Bucket Rescue. A minimum of three employees with CPR and First Aid training are on each crew. Monthly safety meetings with miscellaneous topics and crew input and discussion.
Crew foreman holds weekly safety meetings. The crew foreman also conducts daily job briefings that detail all of the hazards, work duties, special situations, emergency procedures, etc. for work to be done that day.

All employees are trained in the safe use, cleaning, daily testing of the rubber gloves and other protective devices, test equipment, grounding and proper installation of grounding.

All rubber gloves, other rubber devices, hotsticks, are tested by LCRA at 3 to 4 month intervals. Equipment is electric tested once a year and also mechanically tested at the same time.

All training is conducted by referencing The Lineman's and Cableman's Handbook.

David Richardson
Clay Richardson Construction, Inc.

2. Provide a summary description of training programs you provide your employees related to the National Electrical Safety Code for construction of electric transmission and distribution lines.

N/A

Affected Entity: Guadalupe Blanco River Authority **PROJECT NO.** 50595

AFFIDAVIT

I swear or affirm that I have personal knowledge of the facts stated in this report or am relying on people with personal knowledge, that I am competent to testify to them, and that I have the authority to submit this report on behalf of the affected entity. I further swear or affirm that all statements made in this report are true, correct, and complete.

Signature

Kevin Patteson
Printed Name

General Manager / CEO
Job Title

Guadalupe-Blanco River Authority
Name of Affected Entity

Sworn and subscribed before me this 4th **day of** May, 2021.
Month Year

TRICIA L. RAMIREZ
Notary Public, State of Texas
Comm. Expires 12-20-2024
Notary ID 130938645

Tricia L. Ramirez

Notary Public in and For the State of Texas.

My commission expires on 12-20-2024.

SAFETY MANUAL

Prepared by Safety Committee

Guadalupe-Blanco River Authority
933 East Court Street
Seguin, Texas 78155

TWELFTH EDITION 2014

FOREWORD

Maintaining a workplace that protects the health and safety of all employees of the Guadalupe-Blanco River Authority is a core value of our organization. We believe ensuring all of our employees go home at the end of their workday the same as they arrived is of utmost importance.

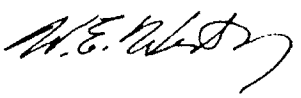
The diversity of GBRA's operations has potential safety hazards that are inherent in each operation whether it's working in a laboratory or office setting, working around high voltages, clearing log jams on the river, delivering raw and treated water to our customers, or operating and maintaining our water and wastewater treatment plants, dams, reservoirs and parks. It is important that each and every employee maintain a constant level of safety awareness while performing their daily work tasks.

This Safety Manual is an effort to assist in safe-guarding the lives and physical welfare of our employees and the public we serve. It formalizes policies and safe practices which govern GBRA in regards to safety. These policies and guidelines have been developed through the years from both internal and external sources. Policies and guidelines cannot be written to cover every possible situation or condition in regard to safety in our workplaces so each employee must use a certain amount of common sense and judgment to:

- Protect himself/herself
- Protect fellow employees
- Protect the general public
- Report unsafe conditions and practices

Personal caution and good safety practices are the best safeguards and I sincerely ask your full cooperation to prevent all accidents. Remember:

"No job is so important, no service so urgent, that we cannot perform our work safely."



GBRA'S SAFETY BASICS

Although this Safety Manual describes many specific rules and procedures, there are a few basic principles that should guide each GBRA employee during every working day.

Safety, of employees and the public, is GBRA's most important organizational objective. For over 20 years, the following simple statement has guided our Safety Program:

> ***"No job is so important, no service so urgent, that we cannot perform our work safely."***

At GBRA, working safely is a condition of employment. GBRA provides personal protective equipment, proper tools, training and a safe working environment. It is up to each of us to use good judgment and common sense, and to adhere to sound policies and procedures, including those found in this Manual. Before attempting any task, each person should "take two" minutes to assess the situation and decide how to safely proceed.

Because of the nature of our profession, we are required to work at all hours, in remote locations, and during inclement weather. Although the water utility profession is one of the safest in the world, individual safety requires our constant attention. Many jobs should never be attempted by one person. Nevertheless, sometimes we are required to work by ourselves. Working alone can be dangerous, depending upon the type of job being performed. Safety is particularly important when employees are called out after normal working hours to respond to unknown problems. In those instances, the employee should assess the situation and determine the type of activity required to correct the problem. If more people are needed to do the job safely, the responding employee will request assistance, and he or she will wait until help arrives before performing the necessary operations or repairs.

As you use this Safety Manual, please make note of questions or sections that need to be improved. Each year the Safety Committee reviews this Manual, and your suggestions are needed to make it a more useful document.

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SECTION 1 GENERAL RULES

SECTION 2 HEALTH AND ENVIRONMENTAL CONTROL

SECTION 3 VEHICLE OPERATIONS

SECTION 4 WORK AREA PROTECTION

SECTION 6 PIPE AND UTILITY POLE HANDLING

SECTION 7 WORK AREAS

SECTION 8 CHEMICAL HANDLING, STORAGE & FIRST AID

5) LAS is corrosive to concrete and some metals such as aluminum and cast iron. Spills should be cleaned up immediately.

6) Do not use or store near strong oxidizing agents, strong alkalis, strong acids, chlorates or nitrates. Heating or addition of strong alkalis or bases causes "ammonia flash" or ammonium which will convert to or release ammonia which can form an ignitable mixture with air near the surface of the liquid.

7) Disposal of waste LAS or dry material generated from the cleanup of spills shall be in accordance with local, state, and federal regulations.

b) First Aid

1) For ingestion, do not induce vomiting. Rinse mouth with water, and then drink large amounts of water. Seek medical attention immediately. Do not give anything by mouth to a convulsing person.

2) For skin contact, remove contaminated clothing under a safety shower. Flush with running water. If irritation develops and persists, seek medical attention.

3) For contact with the eyes, flush eyes with running water for 15 minutes. Remove any contact lenses. Seek medical attention immediately.

4) For inhalation, move person to fresh air and restore breathing. If symptoms persist, seek medical attention immediately.

SECTION 9 ELECTRICAL WIRING AND APPARATUS

901 GENERAL

a) All installations shall comply with the National Electrical Safety Code (NESC), National Electrical Code (NEC), or United States Coast Guard regulations. All work shall be by personnel familiar with code requirements and qualified for the class of work to be performed.

b) GBRA electricians shall be trained and have the competency to safely trouble shoot, repair, and maintain all electrical apparatus required within their job descriptions. Electricians must know their boundaries and never work beyond the scope of the training and experience.

c) Division Manager shall designate in writing employees authorized to perform electrical work.

d) All tools, test equipment and personal protection equipment used for electrical work shall be classified and rated acceptable for use with the voltages present.

e) All equipment circuits shall be de-energized and reported to a Supervisor before work is started and personnel protected by clearance procedures and grounding.

f) At least two persons shall be assigned to work in substations and power plants where the wiring is congested, where the work is at remote or isolated locations, at night, or during inclement weather. One person, trained to recognize the electrical hazards, shall be delegated to watch the movements of the other persons so that he can warn them if they get dangerously close to live conductors or perform other unsafe acts, and so he can assist in case of an accident.

g) When fuses are installed or removed with one or both terminals energized, special tools insulated for the voltage shall be used.

902 DISCONNECT AND OVERCURRENT PROTECTION

Switches, fuses, and automatic circuit breakers shall be marked, labeled, or arranged for ready identification of circuits or equipment supplied through them.

903 GROUNDING

a) All electrical circuits shall be grounded in accordance with the NEC and the NESC unless otherwise noted in this manual.

b) A ground shall be provided for noncurrent carrying metallic parts of such equipment as generators (if not exempted by NEC 250-6), electrically powered arc welders, switches, motor controller cases, fuse boxes, distribution cabinets, frames, motors of electrically operated cranes, and metal enclosures around electric equipment.

c) Semi-portable equipment, floodlights, and work lights shall be grounded. The protective ground of such equipment should be maintained during moving unless supply circuits are de-energized.

d) Ground fault circuit interrupters (GFCI's) are required in all circuits used for portable electric tools and in areas where wet conditions may cause accidental grounding. The GFCI shall be calibrated to trip within the threshold values of 5ma + 1ma as specified in UL Standard 943. All GFCI's shall be UL listed and installed in accordance with the most recent edition of the National Electric Code. The permanent wiring to the GFCI shall be

grounded in accordance with the NEC. GFCI's may be sensitive to some equipment. For these instances, an assured equipment grounding conductor program is acceptable. Isolation transformers may also be used for portable electric tools/equipment where there is the slightest possibility of an electrical shock.

e) Portable electric lighting used in confined wet and/or hazardous locations shall be operated at a maximum of 12 volts.

904 OPERATIONS ADJACENT TO OVERHEAD LINES

a) Operations adjacent to overhead lines shall not be initiated until coordinated with utility officials.

b) Operations adjacent to overhead lines are prohibited unless one of the following conditions is satisfied.

1) Power has been shut off and positive means taken to prevent the lines from being energized.

2) Equipment does not have the capability of coming within a minimum clearance distance of twenty (20) feet from energized overhead lines, or the equipment has been positioned and blocked to assure no part, including cables, can come within the minimum clearance distance of 20 feet.

A notice of the minimum required clearance shall be posted at the operator's position. Electric line derrick trucks and aerial lifts shall not be required to comply with this requirement.

c) Any overhead wire shall be considered to be energized unless and until the person owning such line or operating officials of the electrical utility supplying the line assures that it is not an energized line and it has been visibly grounded.

905 BATTERY CHARGING

a) Batteries and battery chargers shall be located in enclosures with outside vents, or in well ventilated rooms, so arranged as to prevent the escape of fumes, gases, or electrolyte spray into other areas. A "No Smoking" sign will be posted.

b) Facilities for flushing of the eyes and face, and an apron and face shield shall be provided.

c) Facilities shall be provided for flushing and neutralizing spilled electrolyte, for fire protection, for protecting charging apparatus from mechanical damage, and for ventilation dispersal fumes from batteries.

d) When charging batteries, the vent caps shall be kept in place to avoid electrolyte spray. Care shall be taken to assure vent caps are functioning

906 LOCKOUT AND TAGGING OF CIRCUITS

Equipment or circuits that are de-energized shall be rendered inoperative in accordance with Section 109 and Division policy.

907 ELECTRICAL POWER TRANSMISSION

a) Electric equipment and lines shall be considered energized until determined to be de-energized by tests or other means, and grounds applied.

b) Clearance requirements of subparagraph 1 or 2 below shall be observed.

1) No employee shall be permitted to approach or take any conductive object without an insulating handle closer to exposed energized parts than shown in Table 9-1 unless:

(a) The employee is insulated or guarded from the energized part (gloves or gloves with sleeves rated for the voltage involved shall be considered insulation of the employee from the energized part);

(b) The energized part is insulated or guarded from him and any other conductive object at a different potential; or

(c) The employee is isolated, insulated, or guarded from any other conductive object(s).

2) The minimum working distance and clear hot stick distances in Table 9-1 shall not be violated. The minimum clear hot stick distance is that for the use of live-line work.

3) Conductor support tools, such as link sticks, strain carriers and insulator cradles may be used provided that the clear insulation is at least as long as the insulator string or the minimum distance in Table 9-1 for the operating voltage.

TABLE 9-1

ALTERNATING CURRENT - MINIMUM DISTANCE

Voltage Range (phase to phase) kilovolts	Minimum Working and Clear Hot Stick Distances
2.1 to 15	2ft. 0 in. (60.96cm)
15.1 to 35	2ft. 4 in. (71.12cm)
5.1 to 46	2ft. 6 in. (76.20cm)
46.1 to 72.5	3ft. 0 in. (91.44cm)
72.6 to 121	3ft. 4 in. (1.02 m)
138 to 145	3ft. 6 in. (1.07m)
161 to 169	3ft. 8 in. (1.12 m)
230 to 242	5ft. 0 in. (1.52 m)
345 to 362	* 7ft. 0 in. (2.13 m)
500 to 552	* 1ft. 0 in. (3.35 m)
700 to 765	* 5ft. 0 in. (4.57 m)

***NOTE**: For 345-362 kv, 500-552 kv, and 700-765 kv, the minimum clear hot stick distance may be reduced provided that such distances are not less than the shortest distance between the energized part and a grounded surface.

c) De-energized conductors and equipment which are to be grounded shall be tested for voltage. Results of this voltage test shall determine the subsequent procedures required in 907(e).

d) When attaching grounds, the ground end shall be attached first, and the other end shall be attached and removed by insulated tools or other suitable devices. When removing grounds, the grounding device shall first be removed from the line or equipment using insulating tools or other suitable devices.

e) When de-energizing lines and equipment operated in excess of 600 volts, all the provisions of this requirement shall be complied with:

1) The section of line or equipment to be de-energized shall be clearly identified and it shall be isolated from all sources of voltage.

2) Modification and assurance from the designated official shall be obtained that:

(a) All switches and disconnectors through which electric energy may be supplied to the particular section of line or equipment to be worked have been de-energized.

(b) All switches and disconnectors are plainly tagged indicating that persons are at work; and

(c) All switches and disconnectors have been rendered inoperable where design permits.

3) After all designated switches and disconnectors have been opened, rendered inoperable, and tagged, visual inspection or tests shall be conducted to insure that equipment or lines have been de-energized.

4) Protective grounds shall be applied on the disconnected lines or equipment to be worked on.

5) Guards or barriers shall be erected as necessary to adjacent energized lines.

6) When more than one independent crew requires the same line or equipment to be de-energized, a prominent tag for each such independent crew shall be placed on the line or equipment by the designated employee in charge.

7) Upon completion of work on de-energized lines or equipment, each designated person in charge shall determine that all employees in the crew are clear, that protective grounds installed by the crew have been removed, and shall report to the designated authority that all tags and locks protecting the crew may be removed.

f) Measuring tapes or measuring ropes which are metal or contain conductive strands shall not be used when working on or near energized parts.

g) When working near energized lines or equipment, aerial lift trucks shall be grounded or barricaded and considered as energized equipment or the aerial lift truck shall be insulated for the work being performed.

h) With the exception of equipment certified for work on the proper voltage, mechanical equipment shall not be operated closer to any energized line or equipment than the clearances in Table 9-1 unless:

1) An insulated barrier is installed between the energized part and the mechanical equipment;
2) The mechanical equipment is grounded;
3) The mechanical equipment is insulated; or
4) The mechanical equipment is considered energized.

i) Bare wire communication conductors on power poles or structures shall be treated as energized lines unless protected by insulating materials suitable for the highest voltage which may be accidentally applied to the line.

j) Equipotential single point grounding at the work site provides the maximum protection for the line worker by the creation of an equal potential zone. Guidelines for proper installation are:

1) If no ground available, install a temporary screw ground rod as far as reasonably possible from the work location.

2) Install a grounding bracket on the structure where it will be below the line worker's feet.

3) Attach jumper to ground and then to grounding bracket.

4) Test line to verify circuit is de-energized.

5) Clean jumper connections with a hot stick wire brush or use self-cleaning clamps.

6) Attach jumper from bracket to phase conductor.

7) Attach other jumpers such that all conductors are shorted together and grounded.

8) Remove grounds in reverse order.

When installing or removing conductor grounds, use a grip-all hot stick and high voltage rubber gloves.

k) Grounds may be temporarily removed only when necessary for test purposes and extreme caution shall be exercised during the test procedures. The lines or equipment from which grounds have been removed shall be considered energized.

l) When grounding electrodes are utilized, such electrodes shall have a resistance to ground low enough to remove the danger of harm to personnel or permit prompt operation of protective devices.

m) A ground lead, to be attached to either a tower ground or driven ground, shall be capable of conducting the anticipated fault current and shall have a minimum conductance of No. 2 AWG copper wire.

n) When setting, moving, or removing poles by cranes, derricks, gin poles, A-frames, or other mechanized equipment near energized lines or equipment, precautions shall be taken to avoid contact with energized lines or equipment.

o) Unless using protective equipment for the voltage involved, employees standing on the ground shall avoid contacting equipment or machinery working adjacent to energized lines or equipment.

p) Lifting equipment shall be bonded to an effective ground or it shall be considered energized and barricaded when utilized near energized equipment or lines.

q) When there is a possibility of the de-energized conductor being installed or removed accidentally contacting an energized circuit or receiving a dangerous induced voltage buildup, the conductor being installed or removed shall be grounded or provisions made to insulate or isolate the employee.

r) When working in an energized substation, authorization shall be obtained from the designated person before work is started.

s) When work is to be done in an energized substation, the following shall be determined:

1) What facilities are energized; and
2) What protective equipment and precautions are necessary for the safety of personnel.

t) Extraordinary caution shall be exercised in the handling of bus bars, tower steel, materials, and equipment in the vicinity of energized facilities. The requirements in 907.b shall be complied with.

u) Use of vehicles, gin poles, cranes, and other equipment in unguarded high voltage equipment areas shall at all times be controlled by qualified employees.

v) All mobile cranes and derricks shall be effectively grounded when being moved or operated near energized lines or equipment or the equipment shall be considered energized.

w) When switching gang switches, visual inspection should be made to insure all insulators and the switch handle ground are in good condition. Insulating gloves must be worn when operating switch handles.

908 NFPA Standard 70E-2012: ARC FLASH and BLAST

a) The NFPA 70E® 2012 Standard for Electrical Safety in the Workplace provides the best available and most current information on protecting workers against electrical hazards while working on or near exposed electrical conductors or circuit parts that could become energized. Working on energized electrical conductors and circuit parts that expose personnel to shock and arc flash hazards is only permitted under very specific conditions specified under Article 130 of the NFPA 70E® 2012 standard. A copy of this standard, as well as future editions to the standard, shall be kept on file at each GBRA division office for reference.

b) Definitions:

Arc Flash - An arc flash (or arc blast) event is a type of electrical explosion that results from a low impedance connection to ground or another voltage phase called a "short" in an electrical system. A dangerous arc flash can only occur if the fault current is very high – in the range of 1000 amps or more. The massive energy released in the fault instantly vaporizes the metal conductors involved, blasting molten metal and expanding plasma with extreme force that can result in destruction of equipment involved, fire and injury to workers exposed to the arc flash.

Arc Rating - A value of the energy necessary to pass through any given fabric to cause, with 50% probability, a second or third degree burn. This value is measured in calories/cm^2. The necessary arc rating for an article of clothing is determined by a Hazard/Risk Assessment and the resulting Hazard Risk Category.

Calorie - The energy required to raise one gram of water one degree Celsius at one atmosphere pressure. Second degree burns occur at 1.2 calories per centimeter squared per second (cal/cm^2).

Hazard Risk Category (HRC) - HRC is defined in the NFPA 70E standard as a general classification of hazard involved in performing specified tasks. The HRC typically ranges from zero to four with zero denoting minimum-risk activities and four denoting high risk activities. Each category includes the minimum personal protective equipment (PPE) required, the minimum number of layers required to meet this PPE requirement, and the minimum arc rating of all required PPE in cal/cm^2. The Hazard Risk Categories are described in more detail in Appendix VII, Table A of the safety manual.

Personal protective equipment required while working on panel boards and other equipment, motor control centers, and switchgear with power circuit breakers or fused switches is described in sections (c) through (g) below.

c) Panel boards or other equipment rated 240 volts or below.

1) Working on energized conductors including voltage testing is a hazard/risk category 1 and requires arc-rated clothing, insulated rubber gloves and insulated hand tools.

2) Remove/install circuit breakers or fused switches is a hazard/risk category 1 and requires arc-rated clothing, insulated rubber gloves and insulated hand tools.

d) Panel boards or other equipment rated greater than 240 volts and up to 600 volts.

1) Performing infrared thermography outside the restricted approach boundary is a hazard/risk category 1 and requires arc-rated clothing.

2) Circuit breaker or fused switch operation with covers off is a hazard/risk category 1 and requires arc-rated clothing.

3) Working on energized conductors including voltage testing is a hazard/risk category 2 and requires arc-rated clothing, insulated rubber gloves and insulated hand tools.

e) 600 volt class motor control centers (MCCs).

1) Performing infrared thermography outside the restricted approach boundary is a hazard/risk category 1 and requires arc-rated clothing.

2) Circuit breaker or fused switch or starter operation with enclosure doors open is a hazard/risk category 1 and requires arc-rated clothing.

3) Working on energized conductors including voltage testing is a hazard/risk category 2 and requires arc-rated clothing, insulated rubber gloves and insulated hand tools.

4) Working on control circuits with energized conductors and circuit parts greater than 120 volts exposed is a hazard/risk category 2 and requires arc-rated clothing, insulated rubber gloves and insulated hand tools.

5) Application of safety grounds, after voltage test is a hazard/risk category 2 and requires arc-rated clothing and insulated rubber gloves.

6) Opening hinged covers to expose bare, energized conductors and circuit parts is a hazard/risk category 1 and requires arc-rated clothing.

7) Removal of bolted covers to expose bare, energized conductors and circuit parts is a hazard/risk category 4 and requires a 40 CAL/SQ.CM. arc-rated flash suit.

f) 600 volt class switchgear with power circuit breakers or fused switches:

1) Performing infrared thermography outside the restricted approach boundary is a hazard/risk category 1 and requires arc-rated clothing.

2) Circuit breaker or fused switch operation with enclosure doors open is a hazard/risk category 1 and requires arc-rated clothing.

3) Working on energized conductors including voltage testing is a hazard/risk category 2 and requires arc-rated clothing, insulated rubber gloves and insulated hand tools.

4) Working on control circuits with energized conductors and circuit parts greater than 120 volts exposed is a hazard/risk category 2 and requires arc-rated clothing, insulated rubber gloves and insulated hand tools.

5) Insertion or removal (racking) of circuit breakers from cubicles, doors open or closed is a hazard/risk category 4 and requires a 40 CAL/SQ.CM. arc-rated flash suit.

6) Application of safety grounds, after voltage test is a hazard/risk category 2 and requires arc-rated clothing and insulated rubber gloves.

7) Opening hinged covers to expose bare, energized conductors and circuit parts is a hazard/risk category 2 and requires arc-rated clothing.

8) Removal of bolted covers to expose bare, energized conductors and circuit parts is a hazard/risk category 4 and requires a 40 CAL/SQ.CM. arc-rated flash suit.

g) Summary

1) A 12 CAL/SQ.CM. face shield and coat and hearing protection will be worn when:

- Working on ENERGIZED control circuits, on ENERGIZED conductors, or with ENERGIZED circuit parts exposed including voltage testing is a hazard/risk category 1 (240 volts or below) and category 2 (greater than 240 volts and up to 600 volts). Both categories require arc-rated clothing, insulated rubber gloves and insulated hand tools.

- Performing infrared thermography outside the restricted approach boundary is a hazard/risk category 1 and requires arc-rated clothing.

- Operating a circuit breaker, fused switch, or starter with covers off or enclosure doors open is a hazard/risk category 1 and requires arc-rated clothing.

- Application of safety grounds, after voltage test is a hazard/risk category 2 and requires arc-rated clothing and insulated rubber gloves.

- Opening hinged covers to expose bare, energized conductors and circuit parts is a hazard/risk category 1 (600 volt MCCs) and category 2 (600 volt switchgear). Both categories require arc-rated clothing.

2) A 40 CAL/SQ.CM. arc-rated flash suit and hearing protection will be worn when:

- Removing bolted covers to expose bare, energized conductors and circuit parts (600 volt MCCs and switchgear) for any reason including infrared thermography is a hazard/risk category 4 and requires a 40 CAL/SQ.CM. arc-rated flash suit.

- Racking circuit breakers and the removal of buckets from MCCs are hazard/risk category 4 and require a 40 CAL/SQ.CM. arc-rated flash suit.

SECTION 10

BACTERIOLOGICAL AND CHEMICAL LABORATORIES

1001 GENERAL LABORATORY PRECAUTIONS

a) Learn the location of safety equipment including Safety Data Sheet (SDS) notebooks, safety shower, eye wash, fire extinguishers, first aid kits, respirators and safety shields. Do not be afraid to use the protective equipment. Training is available.

b) Put all chipped, cracked or broken glassware into containers marked "For Broken Glass Only" for final disposal. Do not put this material in wastebaskets. In sinks used for washing glassware, removable rubber mesh

Electrical Safety - GBRA

Introductions

- Name
- Organization
- Position
- Work History
- Expectations

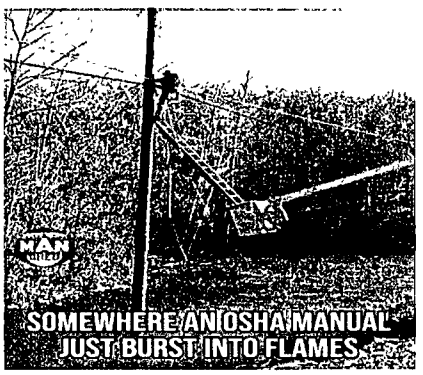
Overview

- Hazards Associated with Electricity
- Definitions for Safety Related Work Practices
- General Electrical Requirements
- General Electrical Safety
- Emergency Response Training (Optional)
- Questions

What is Safety ?

Safety is a state of mind that allows activities to be accomplished without incident and allows logical adjustments to be made to prevent incidents

Why Work Safely?



How Do We Work Safely?

Safety Standards

- OSHA 1910 & 1926
- NFPA 70E
- NESC
- NEC
- IEEE
- National organizations
- Company Safety Manual

What is a Near Miss?

An unintended, unplanned, or unexpected event that could have, but did not, result in personnel injury or property damage

What is an Accident?

An Accident is the interruption of a chain of events that causes injury to personnel, equipment or both to occur

Electrical Work Is:

Hazardous

- Electrocution And Burns Are Significant Causes In Work Related Fatalities
  - A Majority Of These Incidents Occurred *At* ***<600 Volts***
  - Especially To Electricians / Helpers & Construction Workers
- **Arc Flash** & **Arc Blast** Are As Dangerous As Electrocution But Poorly Understood Recognized As Electrical Hazards
- Falls (From Ladders)

Electrical Hazards Statistics

- Each year workers die from contacting electric current
  - –Approximately 212 workers died after contacting electric current
  - – Approximately 77 were construction workers
  - –Approximately 5% of all occupational deaths result from electrocutions

ELECTRICAL HAZARDS

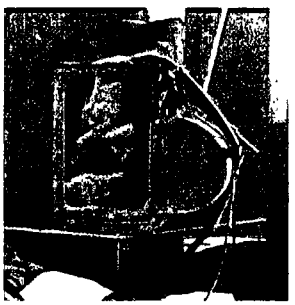
CAUSES:

- Unsafe Conditions
  - Faulty Insulation
  - Improper Grounding
  - Loose Connections
  - Defective Parts
  - Ground Faults In Equipment
  - Ungrounded Live Parts
  - Underrated Equipment
  - Work Environment
- Unsafe Acts (Work Practices)
- Combination

Prevailing Mind Set
"It Won't Happen To Me"
(Famous Last Words)

The Sad Reality

This victim contacted an overhead power line while working from an aerial bucket
NOTE: Most aerial equipment is NOT insulated



Training:

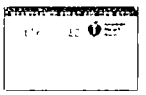
- **WHO** - Employees Who Face A Risk Of Electrical Shock That Is Not Reduced To A ***Safe Level*** By The Electrical Installation Requirements
  - Qualified Persons Who Work On The Equipment
  - Unqualified Persons Who Work Around The Equipment
- **WHAT** - Safety-Related Work Practices Required by OSHA 29 CFR 1910.331 Through 1910.335 That Pertain To Their Respective Job Assignments And Necessary For Their Safety

Training:

Required By 29 CFR 1910.332

- **Workers**
  - Electricians
  - Electrical Engineers
  - Material Handling Equipment Operators
  - Painters
  - Welders
  - HVAC Mechanics
  - Maintenance
  - Industrial Machine Mechanics
- **Their Supervisors**

Training:



1st Aid-CPR

When Employees Are Performing Work On Or Associated With Exposed Lines Or Equipment Energized At 50 Volts Or More, Persons Trained In First-Aid Including Cardiopulmonary Resuscitation (CPR) shall be available

- All Facilities Management Trades Specialists Are To Be Trained is 1st Aid CPR AED
- AHA-Trained Safety Instructors Use The American Heart Association Course Which Requires Certification Every 2 Years

How Electricity Acts:

Behind Turning On An Electric Switch There Must Be

- **Power Source** – The Power Generating Station
- **Transport Method** – Electric Current Travels Through Conductors, Normally In The Form Of Wires

- **Force** – The Pressure To Make Electricity Flow, Measured In Volts, Is Provided By A Generator

How Electricity Acts:

Voltage (V) is Pressure (increasing the voltage will make more current flow)

Current (Amps) is Flow Rate

Resistance (Ohms) to the flow of electricity depends on

- Nature of the Substance
- Length and Cross Sectional Area of the Substance
- Temperature of the Substance

Current = Voltage / Resistance

Electrical Power (Watts) = Voltage x Current

Volts or Amps Kill?

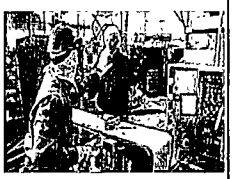
AMPS!

DEFINITIONS

- **Qualified Person** – Those Permitted to Work On *(Direct Contact)* Or Near *(Due To Contact By Means Of Tools Or Materials)* Exposed Energized Parts Due To Training And Experience In The Skills And Techniques Necessary To
  - Distinguish Exposed Live Parts From Other Equipment Parts
  - Determine Nominal Voltage Of Exposed Live Parts
    - Such As 120 240 and 480Y 277
    - Helps Determine Proper Work Procedures For The Job
  - Know The Approach Clearance Distances For The Corresponding Voltages To Which A Qualified Person Can Be Exposed
  - Be Able To Recognize What Protective Equipment And Tools Are Required For The Work Area And Properly Use Them
  - Follow Safe Electrical Work Practices

DEFINITIONS

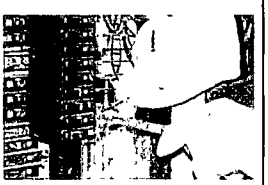
- **Unqualified Person** – Trainee And / Or A Person Who Does Not Meet "Qualified Person" Criteria But Faces A Risk Of Electrical Shock
- **May** – Optional (Recommended)
- **May Not** – Prohibited
- **Shall** – Must Comply



ENERGIZED (Electrically) Electricity Is Flowing Into And Powering A Piece Of Equipment In Order For It To Perform Its Function, i e , The Equipment is "Live" or "Hot"

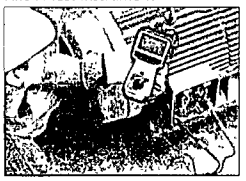
Only **QUALIFIED PERSONS** May Work On Energized Electric Circuit Parts Or Equipment

- Trained To Avoid The Electrical Hazards Of Working On Or Near Exposed Energized Parts



DE-ENERGIZED (Electrically) All Parts Of The Equipment Have Been **Isolated** From Its Electrical Energy Source And **Verified** That It Will Not Operate By Using

- Normal Operating Controls
- And A Test Instrument



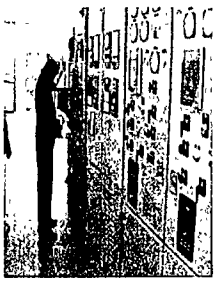
Don't Work It Hot!

Make It Safe

With Careful Planning, Work Can Almost ***Always*** Be Done With Equipment *DE ENERGIZED*

Accessible

- Equipment
  - Admitting close approach
  - Not guarded by locked doors, elevation of other deterrents
- Wiring Methods
  - Capable of removed or exposed
  - Closed in or by structure of building
- Readily
  - Capable being reached quickly for operation, renewal or inspection
  - Requires no ladders and can be reached without climbing over obstacles or barricades

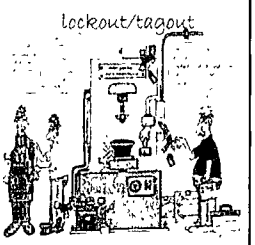


Affected Employee

- An employee whose job requires them to operate or use a machine or equipment on which servicing or maintenance is being performed or working in an area where service or maintenance is being performed

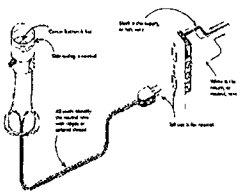
Authorized Employee

- A person who locks out or tags equipment in order to perform service or maintenance to equipment.
- An affected employee becomes an authorized employee when that persons duties include performing service or maintenance to equipment



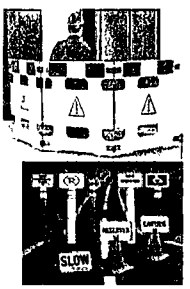
Attachment Plug

- A device by insertion in a receptacle establishes a connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle



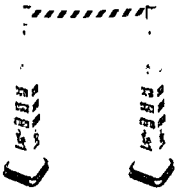
Barricade

- A physical obstruction such as tapes or cones or a frame type wood or metal structures intended to provide warning about and to limit access to a hazardous area



Barrier

- A physical obstruction that is intended to prevent contact with equipment or energized electrical conductors and circuit parts or to prevent unauthorized access to a work areas.



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Bonded

- Connected to establish electrical continuity and conductivity

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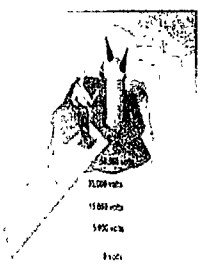
Touch Potential

- Potential difference between earth and another conducting surface with-in a person reach
- Horizontal reach of an average person is about 3 feet



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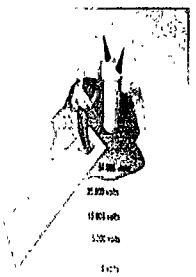
Step Potential

- Potential difference between two points on the earths surface
  - –Based on an average pace
  - –Distance varies 2 to 3 feet



Electrical Shock

- Defined as the process where the body becomes a path for electrical current where the injury results can either be direct or indirect.
  - –Direct shock is the injury that results from flow of current though body
    - Burned tissue
    - Death
  - –Indirect shock is the injury that is the results of the direct shock
    - Fall off a ladder
    - Broken leg, arm or head injury

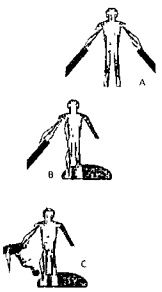
SHOCK HAZARD

Body Becomes Part Of The Electrical Circuit, i.e., In Contact With:

A. **Both Wires Of An Energized Circuit**

B. **One Wire Of An Energized Circuit And The Ground**

C. **"Hot" Part (i e , A Metallic Part Of A Tool In Contact With An Energized Wire) And The Ground**
   - Due To Break In Insulation



SHOCK HAZARD
Severity

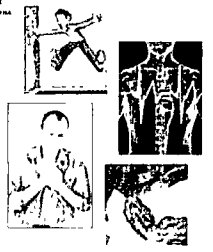
Depends On:

- Current Flow (Amps)
- Path Through Body
- Time
- Frequency
- Heart Cycle
- General Health

SHOCK HAZARD
Effects On Human Body

Danger

CURRENT	REACTION
[illegible]	Current: Pain
[illegible]	Muscle Contraction Can Let Go
[illegible]	Breathing Difficult
[illegible]	Pain Fibrillation DEATH Likely
[illegible]	DEATH Probable
[illegible]	DEATH

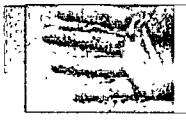


As little as 27 Volts can be FATAL

SHOCK HAZARD
Effects On Human Body

Conductors Offer Little Resistance To The Flow Of Electric Current
- Metals Water

Insulators Have High Resistance to the flow of electric current
- Porcelain, Pottery, Dry Wood



Dry Skin Has A Fairly High Resistance To Electric Current, But When Moist There Is A Drastic Drop In Resistance
Dry Your Hands Before Inserting/ Removing A Power Plug

Potential Variables

- **Body resistance**
  - –Varies with size and composition of person
  - –Values vary from 500 to 1000 Ω
  - –Gender
- **Condition of the surfaces involved with the contact**
  - –Soil (wet, dry, damp, etc.)
  - –Person
    - Skin texture
    - Shoes
  - –Equipment or surface conditions

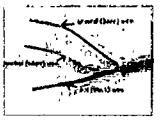
SHOCK HAZARD

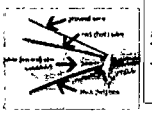
Protective Measures

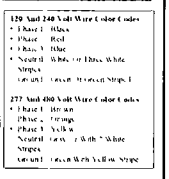
INSULATION

Material Located Between Points Of Different Potential To Prevent The Flow Of Electricity

- Most Common Causes Of Failure - Heat, Dirt, Chemicals, Moisture, Sunlight & Physical Damage





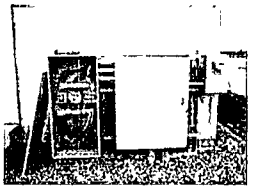


SHOCK HAZARD

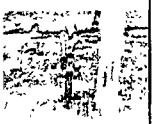
Protective Measures

GUARDING

- **> 50 V** Requires
  - Enclosed Room
  - Permanent Partitions
  - > 8' Above Floor
  - Platform / Balcony / Gallery
- **> 600 V** Requires
  - Metal-Enclosed Equipment
  - Enclosed Vault Controlled by a Lock
  - Marked With Caution Signs



SHOCK HAZARD
Protective Measures



NOT a Guarantee Against Shock

GROUNDING

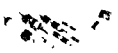
Non-current-carrying Metallic System Components, Such As Equipment Cabinets, Enclosures, And Structural Steel, Need To Be Electrically Interconnected So Voltage Potential Cannot Exist Between Them Then A Low-Resistance Path To The Earth Is Provided

- **Service / System Ground**
  - White / Gray Wire Is Grounded At The Generator / Transformer & At The Service Entrance Of The Building
  - Protects Machines Tools & Insulation Against Damage
- **Equipment Ground**
  - Additional Ground Path From Machine / Tool To The Ground
  - Protects Equipment Operator

SHOCK HAZARD
Protective Measures

Circuit Breakers

GFCIs



Fuse
s

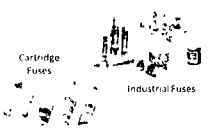
CIRCUIT PROTECTION DEVICES

Protects Worker From Overcurrent & Short Circuits By Automatically Shutting Off The Electricity

- Overcurrent Caused By: Malfunction, Overheating, Too Much On A Circuit, Power Surge, Damaged Insulation

SHOCK HAZARD
Protective Measures

Plug Fuses



Cartridge Fuses

Industrial Fuses

FUSES

- One-Time Use Over-Current Devices
  - **Fast-Blow** / One-Time Protects From Sudden Current Surge
  - **Slow-Blow** / Time Delay Ignores Momentary Current Surges
- Melts / Burns In Two When Set Current Value Is Exceeded
  - 15 / 20 / 30 amps Household
  - 100 / 200 / Greater – Industrial

SHOCK HAZARD
Protective Measures

Circuit Breakers

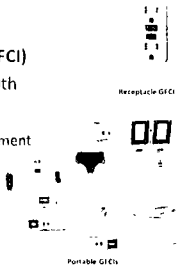
Over-Current Devices Designed To Trip Open The Circuit By Electromechanical Means When Set Current Value Is Exceeded

SHOCK HAZARD
Protective Measures

GROUND-FAULT CIRCUIT INTERRUPTER (GFCI)

Designed To Shutoff Electricity Within 1/40th of a Second

- Compares Current Going Into And Out Of Equipment
  - Interrupts Power If Differs More Than 6 mA
- Prevents Electrocution
- Used In High-Risk Areas
  - Wet Locations
  - Construction Sites



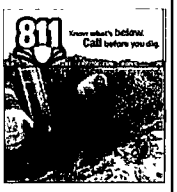
SHOCK HAZARD
Protective Measures

Replace / Reset Circuit Protection

- Random Power Surge Replace Fuse Or Reset Breaker
  - Use Exact Duplicate Fuse
    - Higher Rated Fuse Can Damage Equipment / Start A Fire
    - Lower Rated Fuse Could Explode
- Circuit Breaks Again Or If There Is Smoke, Heat Or Unusual Odor
  - Immediately De-Energize
  - Do Not Keep Resetting Breaker Find The Problem
- Never Bypass, Bridge Or Disable

SHOCK HAZARD
Protective Measures

State Law Any activity that results in the movement or removal of earth, rock or other materials in or on the ground requires the excavator to contact the Utility Company or One Call Center with adequate information regarding the dig Each excavator is required to wait 72-hours or 3 business days before starting the digging work



Underground Utilities

Identify Utility Locations Before Digging

SHOCK HAZARD
Protective Measures

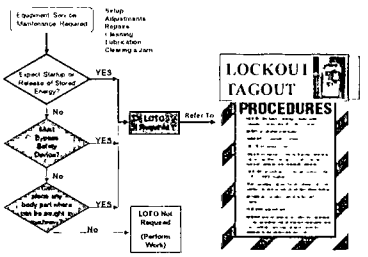
Overhead Power Lines

Prevent Contact

- Unqualified Employees And Mechanical Equipment Must Stay 10' Or More Away
  - Add 4 For Each 10,000V Over 50,000V
- Employees Standing On The Ground May Not Contact The Equipment Unless Clear
- Use CAUTION When Carrying Metal Ladders, Long Pieces Of Pipe, Steel Or Lumber, Or Using Boom Trucks

SHOCK HAZARD
Protective Measures

LOTO



LIVE (HOT) WORK!

Work On Live Equipment Is Only Allowed If It Can Be Shown That De-Energizing.

- Introduces Additional or Increased Hazards
  - Interruption of Life Support Equipment
  - Deactivation of Emergency Alarm Systems
  - Shutdown of Hazardous Location Ventilation Equipment
  - Removal of Illumination for a Critical Work Area
- Is Infeasible Due to Equipment Design or Operational Limitations
  - Diagnostics & Testing of Electric Circuits That Can Only Be Performed With the Circuit Energized (Trouble Shooting)
  - Work on Single Circuit Piece of Equipment Would Shutdown Entire Industrial Process

* Financial or Customer Comfort Considerations are **NOT** Adequate Reasons to Work On or Near Energized Circuits *

LIVE (HOT) WORK! PERMIT

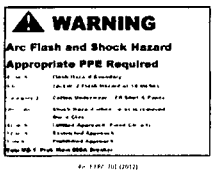
The Supervisor And Employees Complete A **LIVE WORK PERMIT** Designating

- Job To Be Done
- Employees Involved
- Procedures & Tools To Protect The Workers
- Rescue Recovery Operations
- Limited Time Frame

NEVER Work On A Live Circuit Alone
Have Standby Worker Trained In Emergency Response

Electrical Equipment (Switchboards, Panelboards, Industrial Control Panels, Meter Socket Enclosures, And Motor Control Centers) That Is **Likely To Require** Examination, Adjustment, Servicing Or **Maintenance *While Energized*, *SHALL* Be Field Marked With A Label** Containing

- **At Least One Of The Following**
  - Available Incident Energy And The Corresponding Working Distance
  - Minimum Arc Rating Of Clothing
  - Required Level Of PPE
  - Highest Hazard/Risk Category (HRC) For The Equipment
- **Nominal System Voltage**
- **Arc Flash Boundary**



ARC FLASH Hazard

To Minimize Exposure To Arc Flash When Turning Off & Restoring Power –

Use One-Handed Technique

- Wear Appropriate PPE
- Stand To The Side & Sideways
- Use One Hand

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Electrical Burns

- Types of burns
  - –External
    - Classified by depth and degree
    - Severe tissue damage
    - Normally 2 4 days to determine extent
  - –Internal
    - Compare to a microwave
    - Tissue and muscle damage
    - Extent based on entrance and exit site of current source
- Preventive measures

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When Do Arc Blasts Occur?

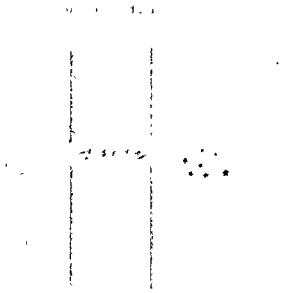
- Accidental contact with live parts
- Conductive object in proximity
- Sparks generated by breakers, fuse or dropped tool
- Over voltage condition
- Insulation failure or corrosion build up
- Presence of fumes or chemical that ionize air

Infrastructure Training & Safety Institute TEEX

Results of Arc Blast

- Thermal radiation
- Pressure wave
  - –Caused by the accelerated temperature change
  - –Severity based on the kA of the arc
  - –Injury to head, body and ears
- Projectiles
  - –Metal particles propelled
  - –Cooling metal become ignition sources and shrapnel
  - –Lethal as much as 10 feet away

Components of an Electrical Arc

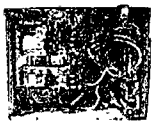


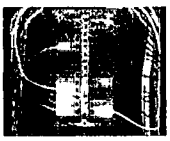
Explosions

- Occur when electricity provides a source of ignition for an explosive mixture
  - –Atmospheric
    - •Gasses
    - •Oxygen rich environment
  - –Component malfunction
    - •Conductors overheating
    - •Contacts overloaded
    - •Arc suppression device failure

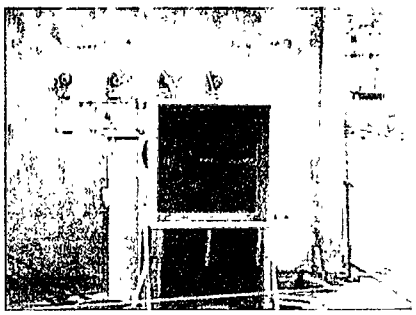
Fire

- **Causes**
  - –Defective equipment
  - –Poorly maintained equipment or facilities
  - –Poor or improperly installed equipment or conductors



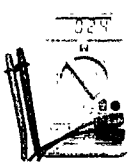


480 Volt Arc Blast



SHOCK HAZARD
Protective Measures

Test Equipment



- Only Qualified Person Is Allowed to Test
- Test The Multi-Meter On A "Live" Source Before Checking Equipment
- Dissipate Capacitors Prior To Testing
- Set To Appropriate Scale Rating (Set High Then Come Down)

LIVE (HOT) WORK!

Electrical Parts Are Considered ***Energized*** Until All Lockout-Tagout (LOTO) Steps Are Completed

- Placing an Electrical Conductor or Circuit Part in a Safe Work Condition (Off & ***De-Energized***) Is in Itself a Potentially Hazardous Task
- Voltage Testing While Completing LOTO Is Considered As Working on Live (Energized) Parts

Personal Protective Equipment
Flame Resistant (FR) Clothing

7,000 Electrical Burn Injuries In The Work Place Each Year

- The Most Severe Burns Are Caused By Ignited Clothing
  - Not From The Initial Arc Flash Fire And Explosion
- **Do Not Wear Synthetic Fabric**

  It ***Melts*** (into your skin)
  - Acetate, Nylon, Polyester, Rayon or Blends

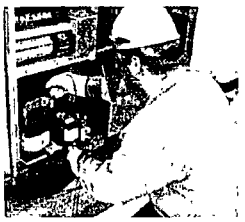
Personal Protective Equipment
Flame Resistant (FR) Clothing

Type Of FR Clothing Required For Work On Or Near Systems Rated At:

- **240 Volts & Below** (Low-Energy work)
  - Natural-fiber / Non-Synthetic Clothing Is Adequate for Many Tasks
  - Some Higher Risk Tasks Require Flame Resistant (FR) Clothing
- **241 - 559 Volts**
  - Requires at Least One Layer of FR Clothing Worn Over Natural-fiber Clothing

For ***Energized*** Electrical Equipment [redacted] < 240 Volts

Facilities Management Trades Specialists Are To Wear



Long Sleeved Cotton Uniform Shirt and Trousers

Leather Work Shoes with Rubber Soles

Safety Glasses (ANSI Z 87 1)

Hard Hat rated for at least 2,200 v (Class E)

Recommended:

Leather Gloves

Arc Flash Rated Face Shield (Over Safety Glasses)

Non-Synthetic Under Layers

For ***Energized*** Electrical Equipment [redacted] 241-599 Volts

Facilities Management Trades Specialists Are To Wear:

Flame Resistant Coverall (Arc Rating 8) AND

Hard Hat rated for at least 2,200 v

Arc Flash Rated Face Shield Over Safety Glasses

Long Sleeved Uniform Shirt and Trousers & Layers Underneath Of Natural Materials (Cotton / NOT Synthetic)

Leather Gloves

Leather Work Shoes with Rubber Soles

Personal Protective Equipment
Arc Rated vs. Flame Resistant Clothing

Arc Rating Of PPE Is To Be Matched To The Arc Flash Hazard

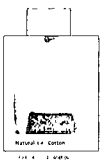
- FR Rating Means The Material Will Not Ignite Or Continue To Burn When Heat Source Is Removed

- Knowing The Arc Rating Of The Equipment Allows The Employee To Make A Proper Selection For FR Protection The Higher The Number The More Protection
  - Not All FR Clothing Is Arc Rated But All Arc Rated Clothing Is Flame Resistant
  - Arc Rated Clothing Provides Insulation To Prevent Fatal 3rd Degree Burns
    - Can Still Receive Survivable 2nd / 1st Degree Burns

Examples If Arc Flash Hazard Is
- 6 Calories Then FR PPE Rating of 8 is OK
- 10 Calories Then FR PPE Rated of 8 Is Not Sufficient, Requires An Additional Layer Or Higher Arc Rated Clothing

Personal Protective Equipment
Arc Rated/Flame Resistant Clothing

- As The Heat From An Arc Flash Can Cause Garments Worn Under Arc Rated Clothing To Ignite, Those Under Layers Should
  - Not Be Made Of Synthetic Materials
  - Be Made Of Natural Materials, I e , Cotton
- Clothing Made From The Following (Synthetic) Fabrics, Alone Or In Blends, Is Prohibited Unless Treated (To Be Flame Resistant) Acetate, Nylon, Polyester, Rayon



Personal Protective Equipment
Hard Hat Ratings

- **Type 1** – Reduce Impact Force From Blow To Top Of Head
- **Type 2** - Reduce Impact Force From Blow To Top Or Sides Of Head
- **Class G (General)** – Reduce Danger Of Contact With Low Voltage (Tested At 2,200 Volts Phase To Ground)

- **Class E (Electrical)** - Reduce Danger Of Contact With Higher Voltages (Tested At 20,000 Volts Phase To Ground)
- **Class C (Conductive)** – Not Intended To Protect Against Electrical Hazards

For *Energized* Electrical Equipment [redacted] 600 Volts & Above (High energy tasks)

(FM Trades Specialists Normally DO NOT Work At These Voltages Assist Power Company)

Flame Resistant Flash Suite
(Arc Rating 40) Worn Over

Arc Flash Rated Face Shield Over Safety Glasses

Leather Work Shoes with Rubber Soles

Leather Gloves

Long Sleeved Uniform Shirt and Trousers & Layers Underneath Of Natural Materials (Cotton / NOT Synthetic)

...and Use Protective Equipment/Insulated Tools


Insulated or Non-Sparking Tools


Grounding Cables


Fuse Pullers


Static Discharge Stick


Dielectric Mats

- Personally Assigned

Rubber / Composition Gloves / Sleeves

- Inspect & Air Test At Start Of Each Day and Each Use
- To Be Regularly Lab Tested Every 6 Months

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When To Wear PPE?

The ARC Flash Protection Boundary

Is The **Minimum Safe Distance** From *Energized* Electrical Equipment Without Need To Wear PPE

- Distance Increases As
  - Fault Current Level Increases
  - The Longer The Fault Is Allowed To Exist
- **Minimum Of 4 Feet** For Systems **600 Volts Or Less**
  - To Prevent 3rd Degree Burn (= Life threatening) (2nd Degree Burn Or Less Is Curable)
- **PPE Must Be Worn Within Boundary** *(50 Volts Or More)*

NFPA 70E 3.1 & OSHA 1910.335(a)(1)(i)

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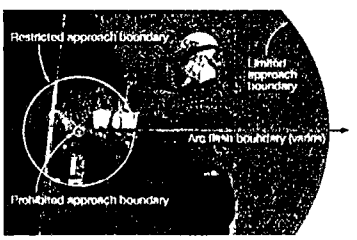
Approach Boundaries (for *"Live"* Electrical Work)



NFPA approach boundaries, 2012 edition

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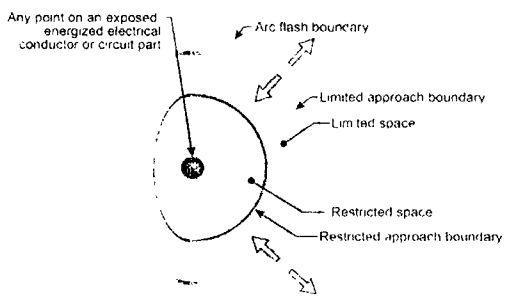
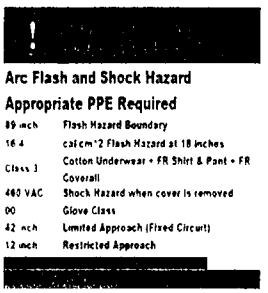
Approach Boundaries



Approach Boundaries to Live Parts

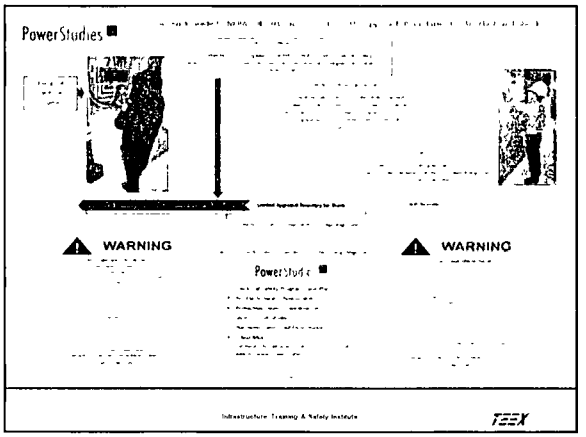
- Shock Hazard Analysis
  - –Voltage exposure
  - –PPE Required
  - –NFPA130.2(A)
  - –Table 130 2 (C)
- Approach by Unqualified Persons
- Flash Hazard Analysis
  - –NFPA 130 3
  - –Injury from arc flash
  - –Flash protection boundaries
  - –Protective Clothing and PPE



NFPA 70E 2012 Table 130.4 (C) (a)

Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection for Alternating Current Systems (All dimensions are distance from live part to employee)

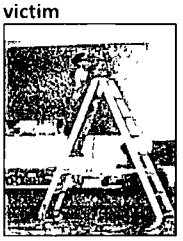
(1)	(2)	(3)	(4)
	Limited Approach Boundary		
Nominal System Voltage Range, Phase to Phase	Exposed Movable Conductor	Exposed Fixed Circuit Part	Restricted Approach Boundary, Includes Inadvertent Movement Adder
Less than 50	Not specified	Not specified	Not specified
50 to 300	10 ft 0 in	3 ft 6 in	Avoid Contact
301 to 750	10 ft 0 in	3 ft 6 in	1 ft 0 in
751 to 15kV	10 ft 0 in	5 ft 0 in	2 ft 2 in
15.1kV to 36kV	10 ft 0 in	6 ft 0 in	2 ft 7 in
36.1kV to 46kV	10 ft 0 in	8 ft 0 in	2 ft 9 in
46.1kV to 72.5kV	10 ft 0 in	8 ft 0 in	3 ft 3 in
72.6kV to 121kV	10 ft 8 in	8 ft 0 in	3 ft 8 in
138kV to 145kV	11 ft 0 in	10 ft 0 in	4 ft 10 in
161kV to 169kV	11 ft 8 in	10 ft 8 in	5 ft 3 in
230kV to 242kV	13 ft 0 in	13 ft 0 in	6 ft 3 in
345kV to 362kV	15 ft 3 in	15 ft 3 in	9 ft 1 in
500kV to 550kV	19 ft 0 in	19 ft 0 in	11 ft 3 in
765kV to 800 kV	23 ft 3 in	23 ft 3 in	15 ft 11 in

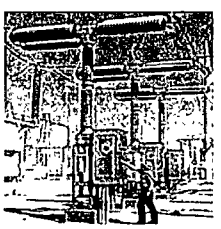


Emergency Response Training (ERT)

Emergency Response Training - ERT

- In case of an accidental electrical shock incident, quick response is essential
- Seconds gained or lost can decide the life or death of a victim





Emergency Response Training - ERT

- **NFPA 70E requires that employees exposed to shock hazards be trained in methods to safely release victims in contact with energized conductors or circuit parts**
- **Refresher training shall occur annually**

First Aid, Emergency Response and Resuscitation

- Employees responsible for responding to medical emergencies shall be trained in first aid and emergency procedures
- Employees responsible for responding to medical emergencies shall be trained in CPR
  - Refresher training shall occur annually
- Employees responsible for responding to medical emergencies shall be trained in the use of AED's if an employer's emergency response plan includes the use of this device
  - Refresher training shall occur annually

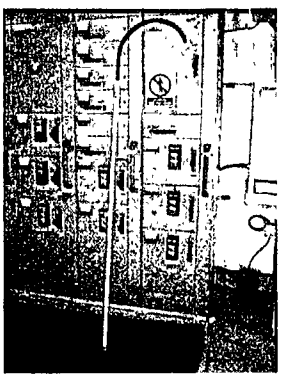
Emergency Response Training - ERT

- **Training Verification**
  - Employers shall verify at least annually that employee training required by NFAP 70E is current
- **Documentation**
  - The employer shall document that the training has occurred
  - Documentation reinforces the importance of training and refresher training

Electrical Contact Release

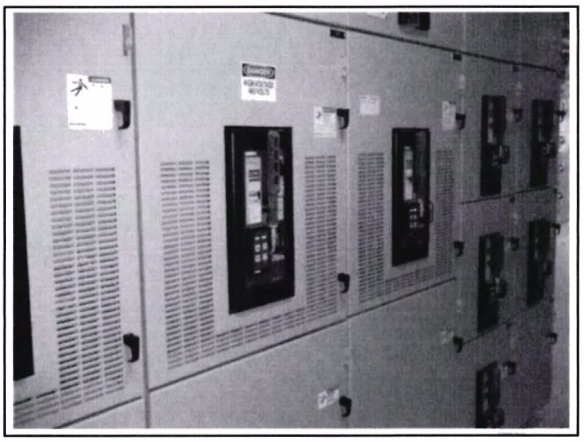
Shock Rescue Kit

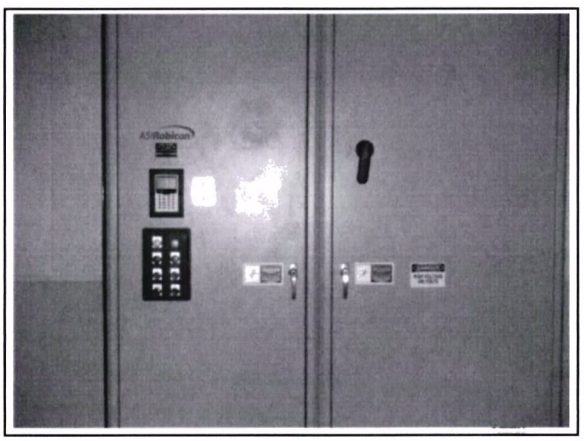
- Insulated hook (Sheppard Hook)
- Rubber gloves
- Rubber blankets or mats
- Other insulated hot sticks
- Dielectric overshoes
- Voltage detector
- First aid kit
- All equipment on a rescue board is preferable



Electrical Contact Release Procedures

- **Evaluate the Scene**
  - Call 911
  - What conditions exist?
  - Escape route(s) if needed
- **Call to victim**
- **Maintain distance**
  - PROVIDE FOR YOUR PROTECTION ! Number 1 Priority!
- **Release victim**
  - Sheppard's Hook is preferred!
  - Other hot stick available
- **Administer First Aid**
  - CPR / AED

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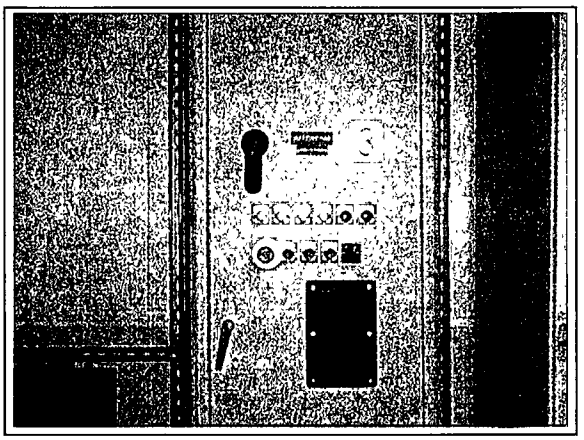

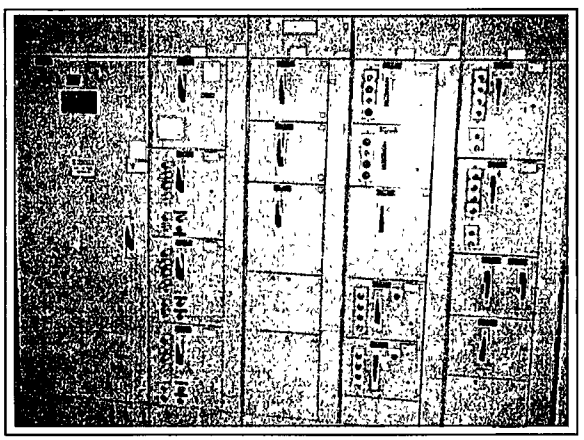

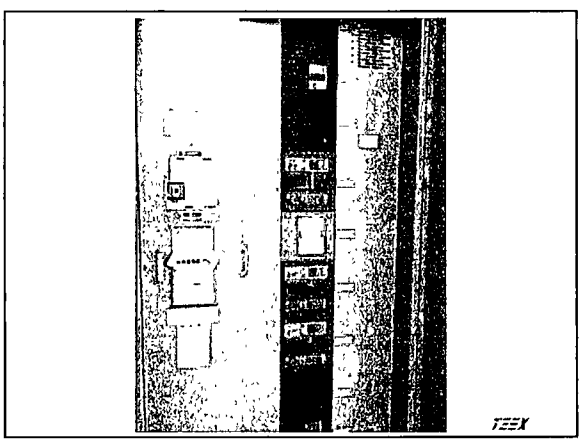

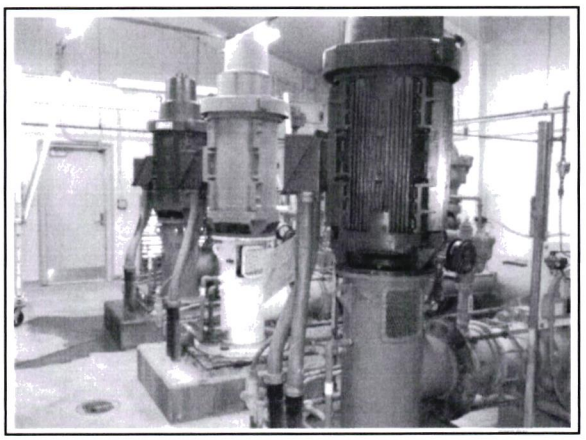

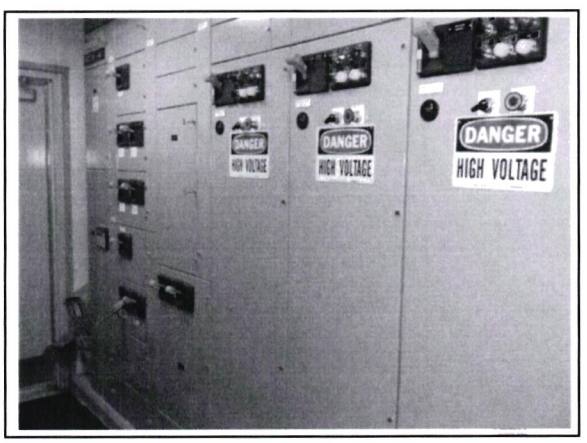
DANGER
HIGH VOLTAGE
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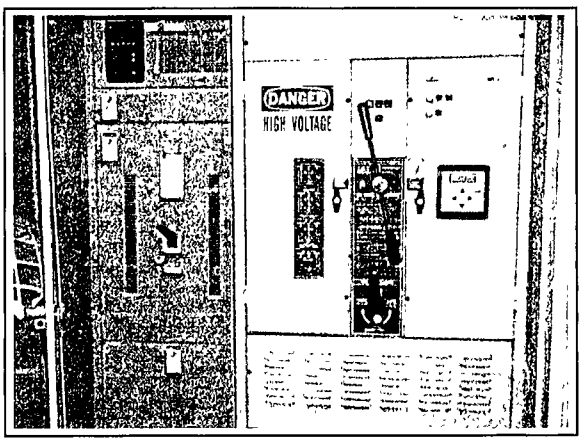
DANGER
HIGH VOLTAGE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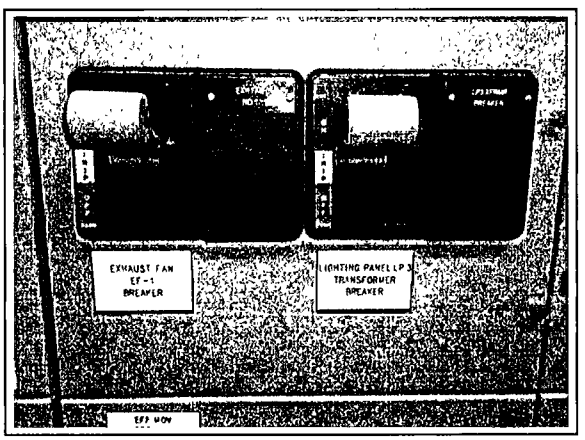
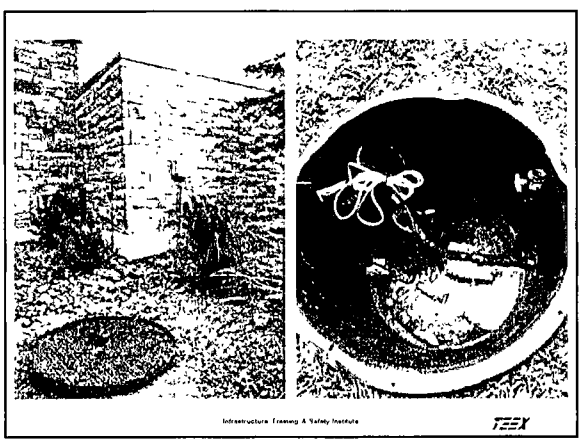
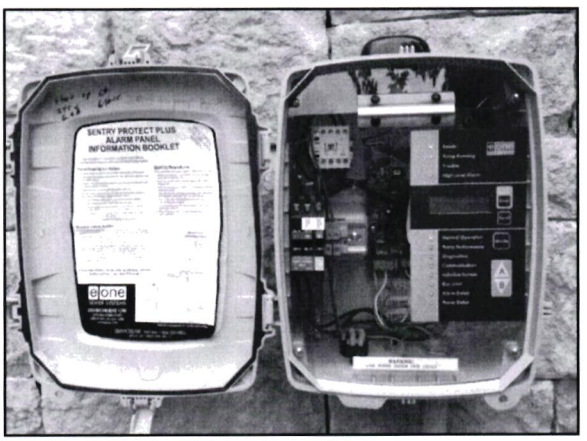
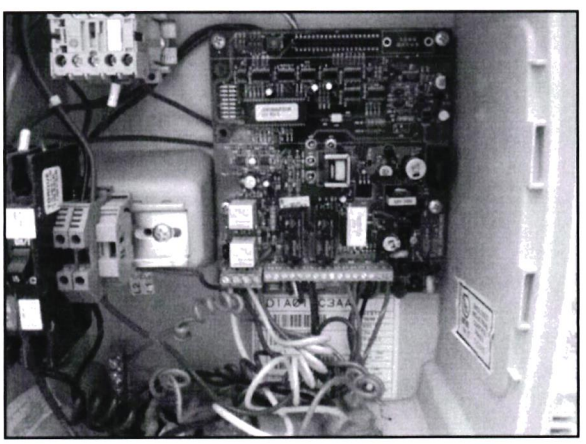
HIGH VOLTAGE


EXHAUST FAN
EF-1
BREAKER
LIGHTING PANEL LP 1
TRANSFORMER
BREAKER


TEEX


CBRA


SENTRY PROTECT PLUS
ALARM PANEL
INFORMATION BOOKLET



Review:

- Dangers of Arc Flash
- Approach Boundaries for Qualified & Unqualified Persons
- PPE (Fire Resistant) Clothing & Tool Requirements
- Posting of Arc Flash Labels
- LOTO Procedures
- Energized Electrical "Live" Work Permit
- Emergency Response Training

Questions?

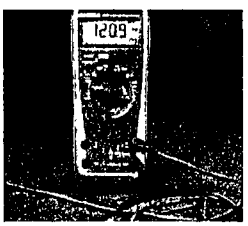
Electric Meters

Overview

- Types of meters
- Applications and use of meters
- Inspection of meters
- Safety

Digital Meters

Multi- Meter

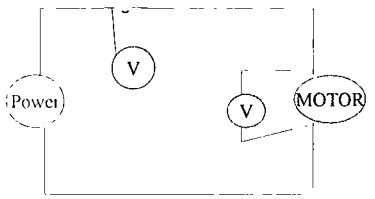


- Measures unknown by measuring time
- LEDs connected to count and store cycles
- Display updated by capacitor discharge

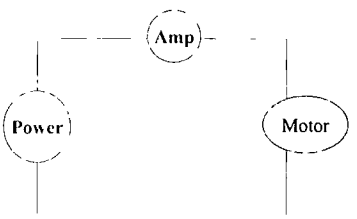
Measurement Instrument

- *Voltage*
- *Current*
- *Resistance*
- *Wattmeter*
- *Power factor*

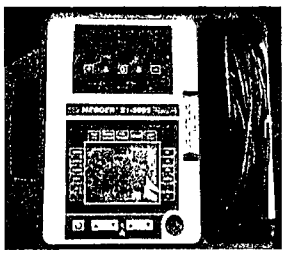
Connecting a Voltmeter



Connecting an Ammeter



Resistance Meters



- Ohmmeter
- Megger
- Hy-pot
- Precautions
  - –Own power supply
  - –Deenergized circuit
  - –High voltage output

Mega-ohmmeter

- Measuring insulation resistance on an AC motor
  - – UOM – Mega-ohm (Million Ohms)
  - – Ground lead connects to machine frame
  - – Ungrounded lead connects to coil circuit
  - – Circuit must be isolated

Formula

$$\text{Mega-ohms} = \frac{\text{Rated Voltage}}{\frac{\text{KVA Rating}}{100}} + 1000$$

- 1 HP = 746 W
- Rule of thumb for minimum insulation resistance is 1 Meg per thousand plus a thousand

Formula

$$\text{Mega-ohms} = \frac{460\ \text{Volts}}{\frac{373\ \text{W}}{100}} + 1000$$

- ½ HP 3 phase motor
- 458 + 1000 = 1 4 Meg Min Ins Resistance

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Watt-Hour Meter

- Measures true power
- Components
  - Voltage coil
  - Current coil
- Two types
  - Self contained (CL 100, 200, etc)
  - Instrument rated (CL 10 20, etc)

EP1 6 13

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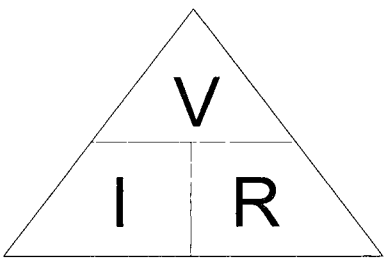
Ohm's Law



EP1 7 7

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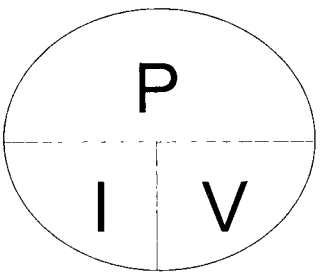
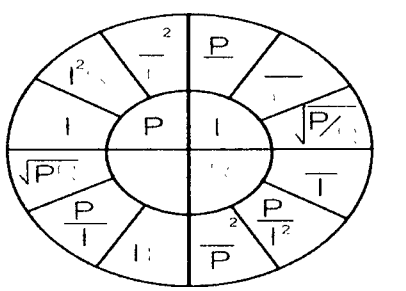
Ohm's Law

- Current is equal to the pressure divided by the resistance
- Current flow is INVERSELY proportional to the resistance

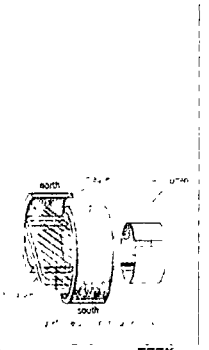
Power Circle



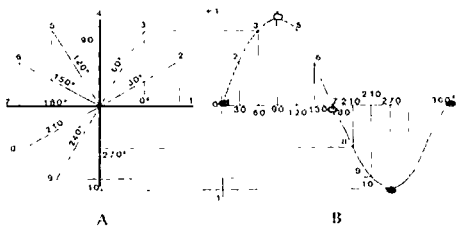


Comparisons

- Direct Current
  - Flow in one direction
- Alternating Current
  - Changes direction
  - Value expressed in frequency hertz or cycles
  - Can be modified



AC Sine Wave



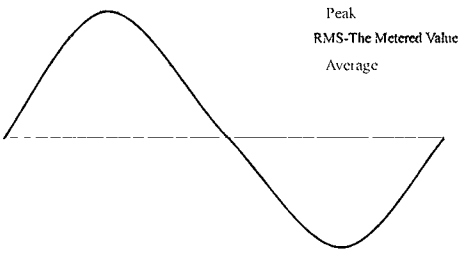
A B

DEVELOPING A CURVE

AC Sine Values

- Maximum or peak
  - 90 degrees or maximum
- Average
  - Equals 0.637 maximum value
- Root mean squared (RMS)
  - Expressed value in AC
  - Equals 0.707 maximum value

Sine Wave Profile



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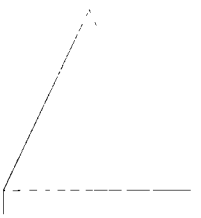
Three-Phase Systems

- Delta
  - –Line voltage
  - –No established relationship to ground
  - –Return on Phase at zero
  - –All connections must be phase to phase



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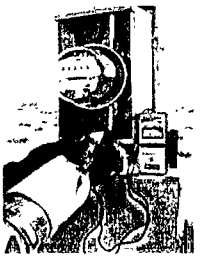
Three-Phase Systems

- Wye
  - –Offers both line and phase voltage
  - –Ground established
  - –Normally four-wire configuration
  - –Ungrounded three-wire uncommon

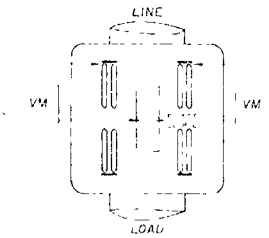
EP1 9-8 Infrastructure Training & Safety Institute TEEX

Voltage Checks

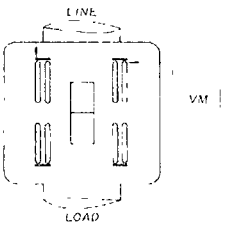
- Select the Meter
  - –Adequate for values
  - –Inspect meter
  - –Wear proper PPE
- Take readings
- Analyze information



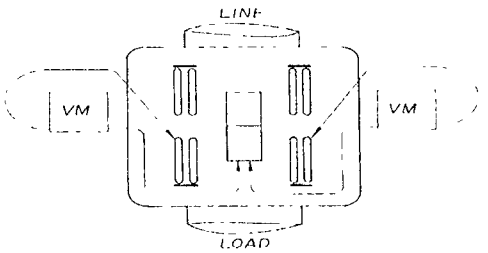
Testing the Phase Voltage



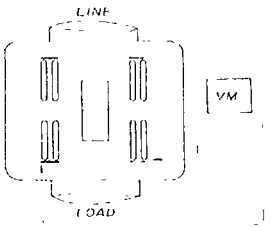
Testing Incoming Line Voltage



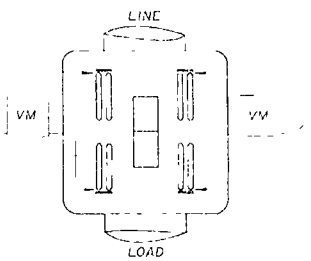
Testing for Back feed



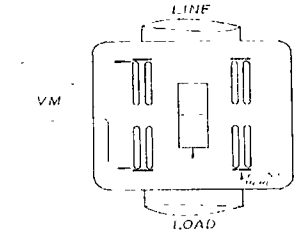
Testing for Back Feed



Testing for Ground

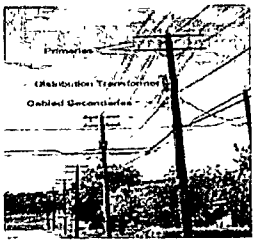


Testing for Short



Standard Service

- Values
  - –120 two wire
  - –240 three wire
  - –120/240/208 3Ø-4W
  - –120/208 3Ø-4W
  - –240 3Ø-3W
  - –480 3Ø-3W
  - –277/480 3Ø4W



Questions ?